



ELSEVIER

Field Crops Research 62 (1999) 177–180

**Field
Crops
Research**

Note on variation in germinability among early-maturing soybean populations

Jeff M. Tyler^{*}

USDA-ARS, Crop Genetics and Production Research Unit, P.O. Box 196, Stoneville, MS 38776, USA

Received 27 October 1998; accepted 17 February 1999

Abstract

Many soybean [*Glycine max* (L.) Merr.] growers in the midsouthern USA have in recent years shifted to an early-season production system. Germination of seed produced in this system is often low. Little is known about genetic variation in early-maturing soybean for seed quality traits. The purpose of this study was to investigate the effect of early maturity on germinability in several soybean breeding populations, and identify parents that may confer improved seed quality on progeny. Nine soybean breeding populations were developed providing a total of 630 F₂ derived lines. Seed from these lines were sown in April (early) in 1995 and 1996 at Stoneville. Maturity date was recorded for each line and seed were harvested less than 1 week after reaching maturity. Standard germination tests were performed on each line. There was a small positive correlation in 1995 ($r = 0.34$), and 1996 ($r = 0.31$) between germination and maturity date, i.e., later lines generally had better germination and populations differed in germination means indicating the existence of genotypic differences in seed quality. Among the 84 earliest-maturing lines in the study, 9 had germinations greater than 80% in both years, suggesting potential for improvement of this trait. © 1999 Published by Elsevier Science B.V. All rights reserved.

Keywords: Seed quality; Germination; Early-maturing cultivars; Soybean

1. Introduction

A significant proportion of soybean producers in the midsouthern USA have in recent years shifted to the early soybean production system (ESPS). Historically southern producers had sown full-season soybean cultivars (MG V, VI, VII) during or after mid-May. This resulted in maturity during October and November. Those plantings were typically exposed to late-summer water deficits during critical growth stages. The crucial component of the new ESPS system is much earlier sowing of Maturity Group (MG) IV and

V cultivars. This often results in avoidance of late-season water deficits.

Seed yield from the ESPS has been equal to or greater than that from the traditional system (May et al., 1989; Savoy et al., 1992; Bowers, 1995; Heatherly, 1996) but germination of seed produced in the ESPS is often low (Mayhew and Caviness, 1994; Tekrony et al., 1996). Increased seed decay, which results in decreased germinability in soybean, has been shown to be associated with increased temperature and relative humidity during seed maturation (Kulik and Sinclair, 1989). Such conditions commonly occur during August when early-maturing soybean is near maturity. Much of the decay is attributed to *Phomopsis* seed decay caused by *Phomopsis longicolla* T.W.

^{*}Tel.: +1-601-686-3127; fax: +1-601-686-3140; e-mail: jtyler@ag.gov

Hobbs and *Diaporthe phaseolorum* (Cooke and Ellis) Saccardo var. *sojae* (S.G. Lehman) Wehmeyer (Tekrony et al., 1996). Mayhew and Caviness (1994) reported, however, that seed from a *Phomopsis*-resistant MG III plant introduction, P1 417479, had only marginally higher germination in some environments than that from other early-maturing lines.

Until very recently, nearly all early-maturing soybean cultivars grown in the southern USA were developed farther North where those cultivars mature later. Those cultivars, therefore, were not exposed to environments such as those that reduce seed germinability in the Southern USA. Mayhew and Caviness (1994) concluded that Southern breeding programs must develop early-maturing cultivars adapted to ESPS. That requires identification of appropriate parental sources but little is known about the genetic variability in soybean for traits that contribute to improved seed germinability.

The objectives of this study were to (1) assess the relationship between maturity date and germination of seed in several early-maturing populations, (2) identify parents, or parental combinations that may impart improved seed germinability to progeny, and (3) identify individual early-maturing lines that have improved seed quality.

2. Materials and methods

Experiments were conducted at Stoneville, Mississippi (33°N) on Sharkey clay (Vertic Haplaquept,

very-fine, montmorillonitic, thermic; USDA taxonomy). In accordance with soil-test recommendations, no fertilizer was applied to any fields used in the study. Soybean crosses were made in the field in 1993 to generate breeding populations for the study. These matings generally involved determinate MG V cultivars crossed with indeterminate MG III, IV, V lines or cultivars (Table 1). The intent was to derive lines within each population that ranged in maturity from late August to early October. This spans the transition from maturity periods resulting in poor seed germinability to maturity periods generally resulting in good seed germinability. F1 plants were grown in a greenhouse during the following winter. F2 plants were grown in the field in 1994. Individual F2 plants were harvested and threshed with a single-plant thresher.

Approximately 70 seeds from each F2 plant were sown on 18 April 1995 in rows 9 m long on a Sharkey clay soil providing 630 individual plant progeny rows. Plots were irrigated twice and two postemergence herbicide (5-[2-chloro-4-(trifluoromethyl)phenoxy]-N-(methylsulfonyl)-2-nitrobenzamide) applications were made to control weeds. Maturity date (R8; Fehr and Caviness, 1977) was recorded for each line. Plots were harvested less than 1 week after reaching maturity. A 200-seed sample from each line was then used for standard germination tests conducted in accordance with *Rules for Testing Seeds* (AOSA, 1987) by the State Seed Testing Laboratory, Mississippi State, MS. In 1996, seed of each line was sown on 26 April. Plot technique, and

Table 1
Germination of seed from soybean lines in nine populations in 1995 and 1996

Population	Pedigree	N lines	1995 mean maturity date	1995 mean % germination	1996 mean % germination
6	HBK49 X Manokin	45	25 September	87 a	76 bc
5	A5979 X RA452	108	26 September	85 a	87 a
7	HBK49 X Crawford	92	16 September	77 b	70 de
8	DP3456 X Holladay	67	23 September	75 b	72 cd
9	DP415 X HS89-3261	45	23 September	74 b	80 b
1	A4715 X (A5979 X DP415)	45	26 September	66 c	86 a
2	A5979 X Crawford	68	20 September	64 cd	69 de
4	A5979 X HS89-3261	75	25 September	64 cd	67 ef
3	A5979 X DP3459	85	28 September	62 d	64 f
LSD (0.05)				4.3	4.8

Means in the same column followed by the same letter are not significantly different ($P = 0.05$, LSD). Due to unequal sample size, LSD differs among comparisons. Mean LSD is shown.

subsequent procedures were the same as those listed above.

Simple correlation analysis was used to assess relationships between maturity date and percentage germination. Germination means of the nine populations were compared using an LSD test.

3. Results and discussion

In 1995 maturity date, for all lines in the study, ranged from 28 August to 6 October. The earliest-maturing population, HBK 49 X Crawford, had a mean maturity on 16 September and the latest, A5979 X DP3456, had a mean maturity on 28 September (Table 1). In 1995 there was a moderate correlation ($r = 0.34$, $P < 0.01$) between maturity date and germination for the 630 lines in the study. A similar correlation was obtained in 1996 ($r = 0.31$, $P < 0.01$). This indicates that germinability of seed from the later-maturing lines was generally greater than that from early-maturing lines. For example, for the earliest 54 lines in the study (those maturing prior to 12 September in 1995) only 6 (11%) in 1995 and 7 (13%) in 1996 had germination levels at or above 80%. Among the 100 latest lines (those maturing 29 September or later in 1995) germinability was much higher. In 1995, 60% and, in 1996, 59% of those lines had germinations at or above 80% (data not shown). These results are generally supportive of the view held by Southern seed producers regarding seed germinability problems in early-maturing lines.

The nine population germination means were compared using a LSD test (Table 1). Populations 6 and 5 were greater in germination than the other populations in 1995. Population 5 also had a high germination mean in 1996. Populations 5 and 6 are relatively late in maturity; however, populations 3 and 4 were similar to them in maturity and produced seed having much lower germination both years. This may indicate that one of the parents of populations 6 and 5 is conferring traits contributing to greater seed germinability.

Populations derived from HBK49 ranked first and third in germination in 1995 despite the fact that population 7 was relatively early (Table 1). This indicates that HBK49 may have imparted traits contributing to greater seed germinability. Population 5 was derived from A5979 and RA452. Populations 2, 3,

and 4, derived from A5979, had poor average germination indicating that RA452 rather than A5979 conferred greater seed germinability in population 5. Roy et al. (1994) reported that RA452, when compared to six other MG IV cultivars at three Mississippi locations, had less *Phomopsis* infection, than the other cultivars. The germination means of populations 2, 3, and 4 reveal that relatively later-maturing cultivars such as A5979, which usually have no germination problems, may not necessarily have or confer needed seed quality traits to their early-maturing progeny.

Soybean breeders would like to identify early-maturing breeding lines that consistently produce seed having commercially acceptable germination levels. In this study there were 84 lines that matured earlier than 16 September in 1995. Among those, only nine lines had germination means above 80% in both years (data not shown). This indicates that it may be possible to develop early-maturing lines that have improved seed germinability, although they are likely to be in low frequency. The differences in mean germination found among populations with similar maturities indicate that genotypic differences exist in this set of populations.

Results in this study reveal that RA452 and HBK49 may be sources of traits contributing to improved germination for early lines. Additional research is needed to identify other lines that confer traits impacting germinability and to determine the inheritance of those traits.

Acknowledgements

This research was partially funded by a grant from the United Soybean Board.

References

- AOSA (Association of Official Seed Analysts), 1987. Rules for testing seeds. *J. Seed Technol.* 6, 1–126.
- Bowers, G.R., 1995. An early soybean production system for drought avoidance. *J. Prod. Agric.* 8, 112–119.
- Fehr, W.R., Caviness, C.E., 1977. Stages of soybean development. *Iowa Agric. Exp. Stn. Spec. Rep.* 80, Iowa State University, Ames.
- Heatherly, L.G., 1996. Yield and germinability of seed from irrigated and nonirrigated early- and late-planted MG IV and V soybean. *Crop Sci.* 36, 1000–1006.

- Kulik, M.M., Sinclair, J.B., 1989. Seed pathology. In: Sinclair, J.B., Backman, P.A. (Eds.), *Compendium of Soybean Diseases*, 3rd ed., APS Press, St. Paul, Minnesota, pp. 72–80.
- May, M.L., Caviness, C.E., Eldridge, I.L., 1989. Soybean responses to early planting in northeast Arkansas. *Ark. Farm Res.* 38, 5.
- Mayhew, W.L., Caviness, C.E., 1994. Seed quality and yield of early-planted, short-season soybean genotypes. *Agron. J.* 86, 16–19.
- Roy, K.W., Ratnayake, S., Keith, B., 1994. Soybean seed quality ratings and cultivar reactions to *Phomopsis* and other seed Pathogens. *Agron. Abstr.*, 177.
- Savoy, B.R., Cothren, J.T., Shumway, C.R., 1992. Early-season production systems utilizing indeterminate soybean. *Agron. J.* 84, 394–398.
- Tekrony, D.M., Grabau, L.J., DeLacy, M., Kane, M., 1996. Early planting of early-maturing soybean: effects on seed germination and *Phomopsis* infection. *Agron. J.* 88, 428–433.